HYDROGEOLOGICAL STUDY
HAMLET OF CAMPBELLVILLE

ON BEHALF OF

REGIONAL MUNICIPALITY OF HALTON

FINAL REPORT

PROJECT No. 81-126

OCTOBER, 1982

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Gartner Lee Associates Limited

Consulting Engineering Geologists and Hydrogeologists

Toronto-Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-477-8400

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October 21, 1982.

The Regional Municipality of Halton,
Public Works Department,
P.O. Box 7000,
1151 Bronte Road,
Oakville, Ontario.
L6J 6E1.

Attention: Mr. R. McMurray, P.Eng.
Supervisor,
Budget and Development

Dear Sirs:

Re: Hydrogeological Investigation Hamlet of Campbellville - GLAL Ref. 81-126

We respectfully submit the outstanding twenty-five copies of our Final Report for the above noted study, for your attention.

This document contains a complete description of our preliminary hydrogeological study and presents our conclusions and recommendations covering future development based on hydrogeological considerations.

The study area is blessed with a good supply of ground water resources. These ground water resources, from a quality aspect, however, could be directly affected by surface development practices. The major aquifers are hydraulically connected to surface recharge. Contaminants introduced on or into the ground surface have the potential to affect the ground water quality in the aquifers. The elevated chloride and sodium content of the ground water from the granular aquifer is a good example of this. The amount of ground water flow, however, generally provides a good

potential for dilution of offending contaminants. Thus, the density and type of development should be balanced with this dilution available, to provide adequate protection of the ground water resource.

We have completed theoretical calculations based on available data to provide a rationale for future development densities, and these are discussed in the report.

If individual wells are proposed for future developments, then we conclude that the minimum net lot size be 0.6 ha (1.5 acres) in size to provide a safe dilution of nitrates from septic systems. If a communal well is developed, then our calculations suggest that the minimum net lot size could be reduced to 0.3 ha (0.75 acres) in size.

Future proposed expansions of the commercial sewage disposal systems immediately north of Highway 401 could have an impact on water supplies located immediately downgradient from them in the area of the Hamlet of Campbellville. Theoretical calculations based on available data suggest this as a possibilty. If future development is to rely on individual well supplies, then more detailed investigations are required to verify this preliminary conclusion and to quantify the potential impact on water quality.

Alternatively, the safest, but most expensive, solution would be to locate a communal well north of the Racetrack developments and upgradient of any potential contaminant sources.

Our report recommends the following:

1. If development on individual wells immediately downgradient from the commercial sewage disposal area north of Highway 401 is decided upon, then a detailed hydrogeological study is required to determine the potential impact of contaminant migration from the disposal area on the water supply.

2. If a communal well is contemplated then it should be located upgradient of the commercial sewage disposal area. A detailed hydrogeological study should be undertaken to optimally locate and evaluate a suitable municipal supply.

3. If future development is to depend on individual well supplies, then the developer should be asked to confirm the adequacy of each supply, based on actual pump test data. Septic tanks and wells should be sited as per MOE guidelines with maximum separation to optimize dilution effects. Also, we suggest that the water quality from the existing communal well, located in the granular aquifer, continue to be monitored, with particular attention paid to the chloride and sodium content.

While the study area has a good supply of ground water, the direct hydraulic connection between surface activities and ground water supplies produces a sensitivity to the area in terms of protecting the quality of ground water resources. The balance of development with natural dilution available is the key to successful development. This requires detailed hydrogeological evaluations.

We thank you for the opportunity to present this report to you.

Respectfully submitted,
GARTNER LEE ASSOCIATES LIMITED

A.G. Hims.

A.G. Hims, P.Eng.
Project Manager

AGH:dg

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1.0 INTRODUCTION:

The Public Works Department of the Regional Municipality of Halton is undertaking a series of hydrogeological studies within the rural communities of the Region. The purpose of these studies is to characterize the geological and ground water settings of the hamlets in order that the long-term adequacy of the ground water supplies to support the existing as well as future development can be determined. Also, as part of the studies, it is necessary to determine the ability of the soils to safely accommodate septic wastes with regard to the potential impact of these wastes on the ground water supplies. Based, in part, upon the findings of these studies, Secondary Plans will be developed for each area in which recommendations for ground water supply and lot size for new developments will be designated.

This study at Campbellville was undertaken by Gartner Lee Associates Limited at the request of the Public Works Department of the Region. Authorization to proceed with the project was received from the Region in the form of Purchase Order No. 41861 on October 19, 1981.

1.1 PURPOSE AND SCOPE:

The Terms of Reference for this study are contained in Appendix 3 to this report. Essentially, the study is intended to describe the geologic and ground water setting

of the Hamlet of Campbellville based entirely on existing available information. Subsurface field work was not included with the study. The characteristics of the ground water aquifer(s) in the area were to be described and their adequacy to provide a long term water supply, to both existing and future development, determined. Also, an evaluation of the existing communal well was required, together with an indication of the preferred location for a second communal well capable of supplying the existing and future development. The minimum lot size of future developments, based on ground water availability, was to be assessed. An assessment of the impact of subsurface disposal of septic wastes from existing and future development, on the water supply for the existing community and also for the Town of Milton was to be provided.

1.2 ADDITIONAL WORKS:

Upon being awarded tne contract, Gartner Lee Associates Limited was requested by the Region to assess, in as much detail as possible, the potential impact of the sewage disposal practices of the existing and proposed expansion of commercial developments, located immediately north of Highway 401, on the ground water supplies for Campbellville and also the Town of Milton. The results of this additional work have been included in this document in order to provide as complete a report as possible on the ground water supplies for Campbellville.

1.3 LOCATION OF STUDY AREA:

Campbellville is centered around the junction of Guelph Line and No. 5 Sideroad (locally Campbell Avenue), in the former Township of Nassagaweya, as shown on Figure 1. The existing hamlet consists of private residences for the most part with small commercial and cultural enterprises located in the village core. Three fairly major commercial enterprises are located just north of the hamlet, immediately north of Highway 401. These are the Mohawk Raceway, Mohawk Inn and K.O.A. Campgrounds.

2.0 METHODOLOGY:

A full description of the methodology used in this study is contained in Appendix 2. Essentially, the study consisted of a review and analysis of the existing published geological and hydrogeological maps, reports and Ministry of the Environment water well records pertaining to the area. Aerial photographs were stereoscopically interpreted to provide additional data on the physical setting. We were then able to characterize the surface soils and ground water aquifers within the area. Discussions were held with Regional staff, residents and commercial property owners regarding the existing and future ground water usage and disposal practices. These data were analyzed and this report prepared to document the study findings, details of which are presented below.

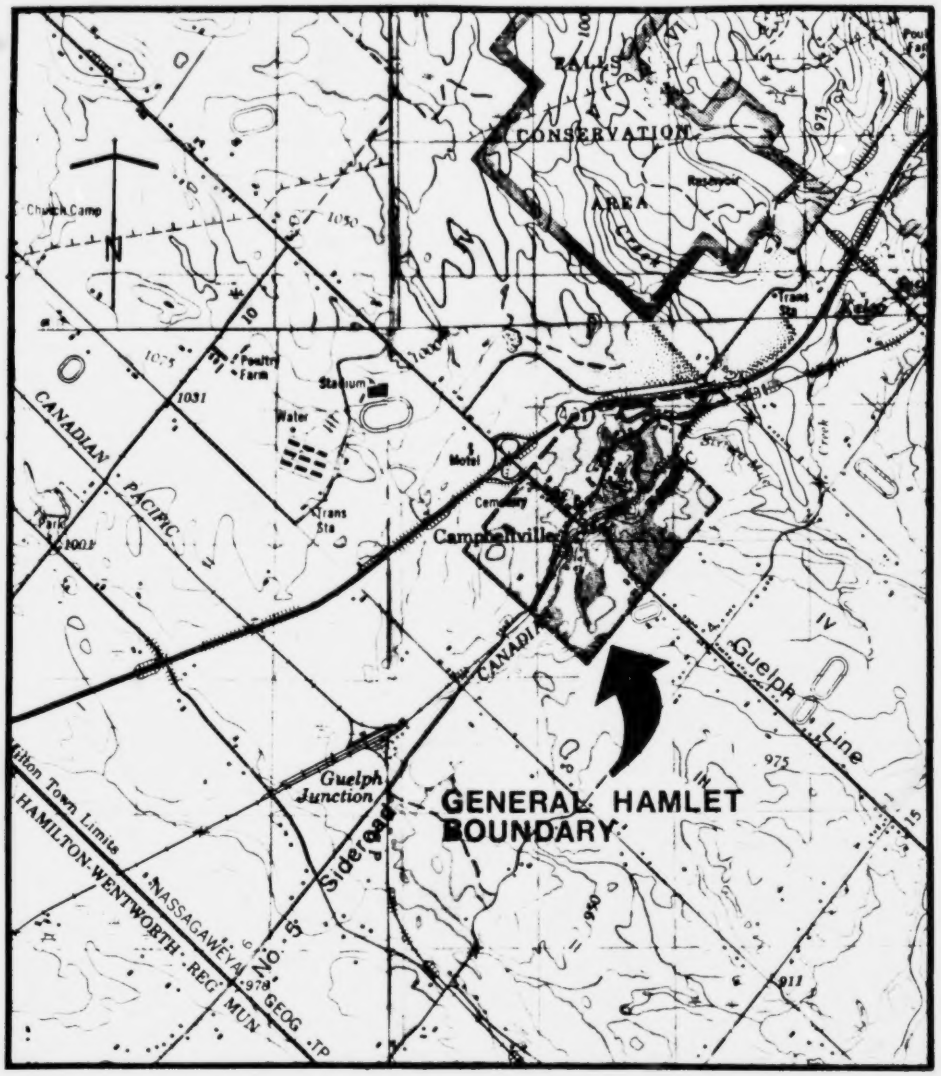

Figure 1

KEY MAP

Scale 1:50,000

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3.0 STUDY FINDINGS:

3.1 PHYSICAL SETTING:

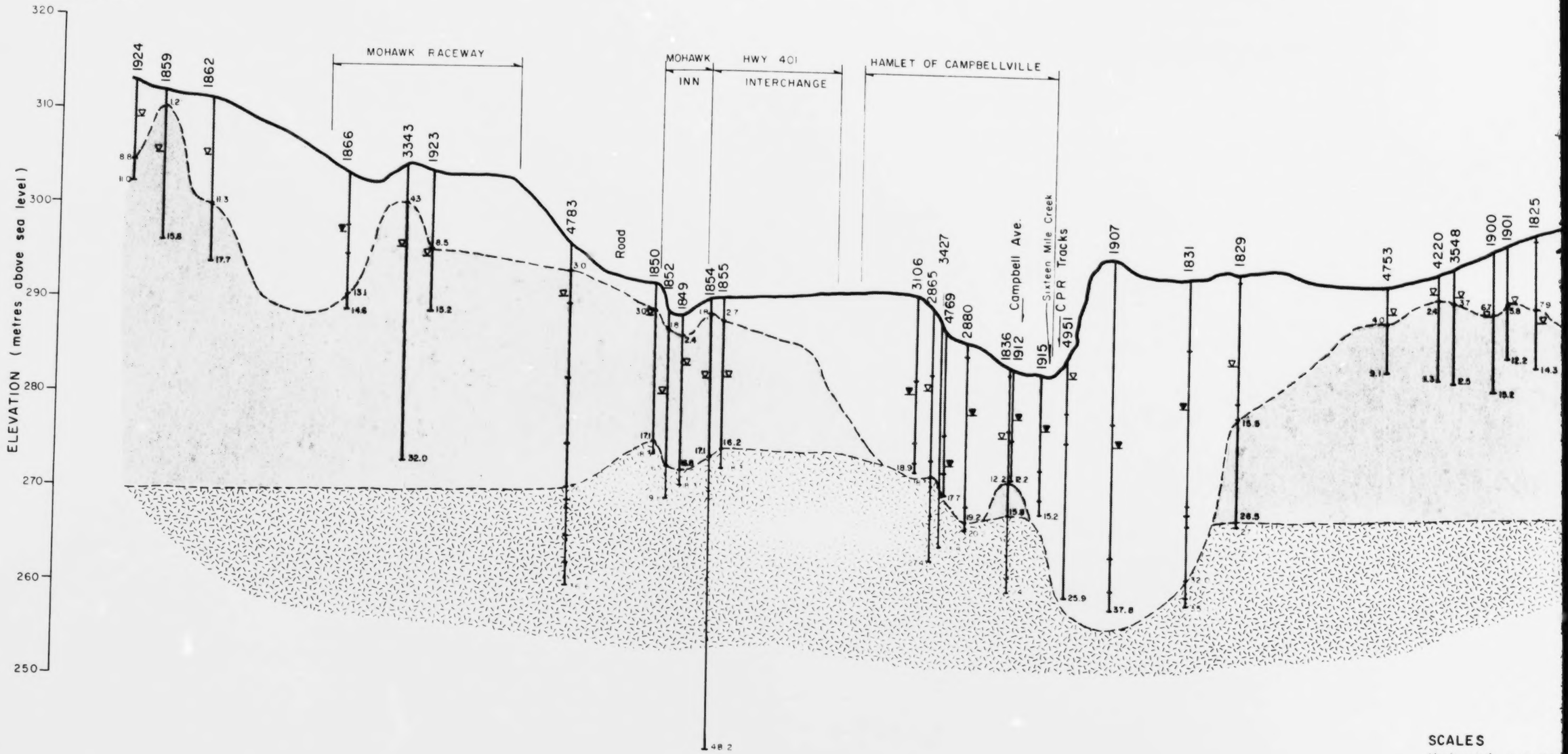
Figure 4 in the Appendix shows the general physical setting and terrain units interpreted in the study area.

3.1.1 TOPOGRAPHY, DRAINAGE AND CLIMATE:

Campbellville is located approximately 1.5 km southwest of the Niagara Escarpment, which forms the dominant topographic feature of the region. Within the hamlet boundary, the land is dissected by the Sixteen Mile Creek valley which runs from west to east through the center of the hamlet. Immediately south of the railway tracks the land rises steeply away from the valley. Above the valley, the land becomes relatively flat. To the north, the land rises more gently towards Highway 401 and becomes gently to moderately rolling.

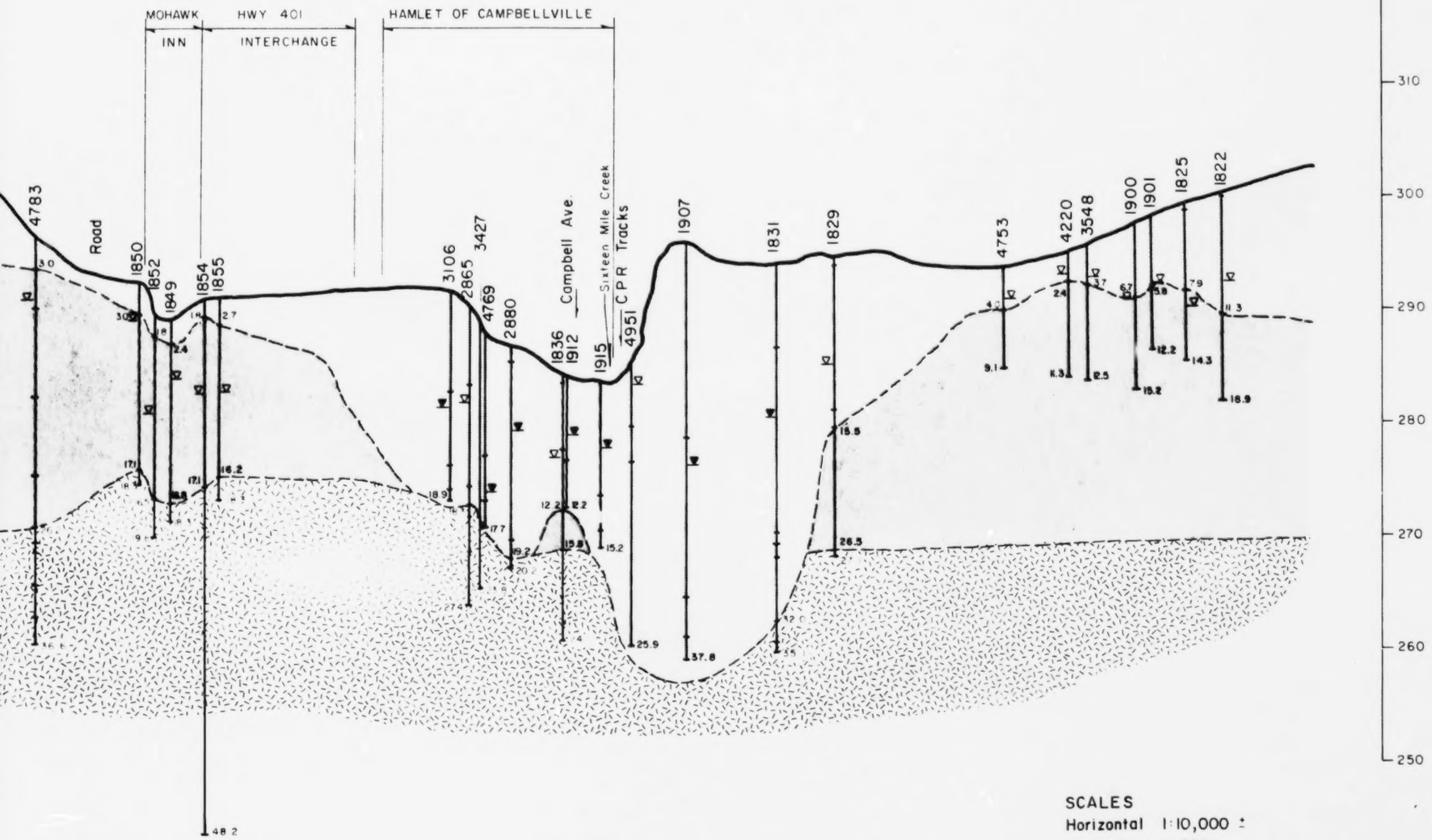
The majority of the hamlet lies within the Sixteen Mile Creek watershed, which forms the major surface drainage course in the area. Sixteen Mile Creek joins Oakville Creek just east of the hamlet boundary. A small portion in the southwest corner of the hamlet lies within the drainage basin of a tributary of Bronte Creek. Surface drainage within the hamlet is, for the most part, fairly good, indicating the granular nature of the surficial soils. Poorer drainage conditions do occur along the flanks of the stream courses giving rise to seasonal wetlands. Ponding, both natural and artificial occurs along Sixteen Mile

A
North



SCALES
Horizontal 1:10,000
Vertical 1:400

A′
South



SCALES
Horizontal 1:10,000 ±
Vertical 1:400

Legend

- Glacial Overburden Soils (kame sands and gravels and/or sand till)
- Grey Dolomite (Amabel Formation)
- Red & Blue Shale (Cataract Group)
- 4753 — MOE Well Location & Designation
- 40 — Depth To Major Strata Change (m)
- 91 — Depth To Base Of Well (m)
- ▼ Water Level In Overburden Well At Time Of Construction
- ▽ Water Level In Bedrock Well At Time Of Construction

NOTE - Well log data transposed onto section line. Elevation of bedrock surface shown above may vary slightly from that indicated on bedrock topography map

Cross-Section A-A′ | **2**

Hydrogeological Investigation
Hamlet Of Campbellville
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Regional Municipality Of Halton

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Creek in the village core and to the east. It is likely that ground water provides the baseflow for both Sixteen Mile and Oakville Creeks.

Figure 3 in Appendix 1 provides details of temperature and precipitation records for the Galt weather station. Using the Thornthwaite method, the mean total annual precipitation is 868 mm (34 inches) and mean total annual potential evapotranspiration is estimated at 615 mm (24 inches). Thus, approximately 253 mm (10 inches) of precipitation are available annually for infiltration and surface runoff. We estimate on the basis of the MTC approach that runoff will generally account for about 100 mm (4 inches) in this setting, leaving in the order of 150 mm (6 inches) as infiltration to recharge the ground water. Obviously, actual infiltration will vary throughout the hamlet depending upon soil type, slope and degree of development.

3.1.2 SOILS:

The general distribution of soils both within the hamlet and in the surrounding area is shown on Figure 4, Physical Setting in the Appendix. Figure 2, which follows, is a cross-section from north to south along the Guelph Line to illustrate the subsurface geology, as derived from MOE water well records.

Four distinct soil types can be distinguished. Much of the central section of the map area consists of fairly deep granular soils of kame or glacial origin, i.e. outwash

sands and gravels. The deepest soils, which are in excess of 40 m, are located within a buried bedrock valley structure present just to the south of, and approximately parallel to, the railway tracks east of the village core. A second, fairly deep, soil unit is located in the southern part of the hamlet and consists of a glacial silty sand till. This unit occurs above the steep slope south of the village core, and much of the McClaren subdivision is built on this soil type. Much of the area to the northwest of the Highway 401 interchange, and also a smaller area south of the hamlet boundary, consists of shallow soils overlying bedrock. These soils which are usually less than 7.5 m deep, and very often are much less than this, comprise either a bouldery till and/or sands and gravels over the bedrock. The last major soil type consists of organic soils which occur in the low, poorly drained areas along the flanks of the drainage courses.

3.1.3 BEDROCK:

Figure 2, Cross-Section A-A' and Figure 5, Bedrock Topography contained in the Appendix, illustrate the general contours of geometry of the buried bedrock surface. Two bedrock stratigraphic units are represented here. The upper unit is grey dolostone of the Amabel Formation which overlies red and blue shale of the Cataract Group. Beneath Campbellville and to the east, the bedrock has been eroded into a fairly deep -- 40 m (130 feet) -- valley during preglacial times. The valley, whose axis trends approximately west-east, is now buried beneath the overburden soils. Within the buried valley, the dolostone is absent, and the shale bedrock that underlies the granular overburden forms the floor of the valley.

Upon the flanks of the valley the dolostone is present and attains a maximum thickness of approximately 20 m (65 feet) along the walls in this area. The infilled valley becomes less prominent west of Campbellville, however, it can be traced eastwards beneath the Kelso Reservoir and beyond. This structure forms one ground water aquifer for Campbellville, and also for the Town of Milton at the Kelso well field.

3.2 GROUND WATER AQUIFERS:

Figure 4 in the Appendix shows the approximate location of the water wells used in the study, as obtained from MOE records. Table 1 in Appendix 1 provides details of these wells which are representative of the ground water conditions around Campbellville. Table 2 provides details of well capacities for the various aquifers. These data are provided in imperial units in the tables, in line with the Ministry records. The text provides a summary in both metric and imperial units. Table 3 provides the results of the chemical analyses of the ground water obtained from the various aquifers.

Essentially two major, and one minor, aquifers are present in the Campbellville area. The dolostone bedrock provides the main ground water supply. This is in the areas to the north, south and west of Campbellville. Much of the village itself, including the one communal well, obtains ground water from the granular overburden soils present within the buried bedrock valley. Some

wells within the village and to the east obtain water from the shale bedrock which forms the floor of the minor aquifer in the area.

3.2.1 DOLOSTONE BEDROCK:

Figure 6 in the Appendix provides static water level data and general ground water flow conditions within the bedrock, as derived from the Ministry records. As would be expected, the ground water flow in the dolostone appears to be from the higher ground toward the buried valley structure. Hydraulic gradients appear to be low, ranging from about 0.01 to 0.04.

The dolostone provides the major aquifer in those areas where it is present. The wells generally obtain water from the upper 3 m to 6 m (10 to 12 feet) of the dolostone where the rock is most weathered and fractured. The relevant well yield data from the dolostone aquifer are provided below:

Average Yield	= 60 L/min (13 gallons/min)
Range	= 4.5-182 L/min (1 to 40 gallons/min)
High Yield	= 455 and 510 L/min (100 and 112 gallons/min) (Two Mohawk Raceway wells)
Average Specific Capacity	= 22 L/min/m (1.5 gallons/min/foot)
Range	= 0.15-150 L/min/m (0.01-10 gallons/min/foot)

Using the above data together with an available saturated thickness of about 20 m, the apparent transmissivity of

the dolostone aquifer is in the order of 32 m^2/day (2100 gallon/feet/day). Due to the "fractured-flow" nature of ground water movement in the dolostone, the above values may vary considerably throughout the area.

The chemical quality of the two water samples obtained from wells developed in the dolostone is within Provincial guidelines for a drinking water source and probably can be considered as background values.

3.2.2 SHALE BEDROCK:

The Cataract shale bedrock is sometimes utilized as a ground water source in those areas where the dolostone is absent, as within the buried valley. A few wells have been carried into the shale when insufficient water was available from the dolostone. The shale is a poorer aquifer than either the dolostone or the granular overburden. The relevant well yield data are provided below:

Average Yield	= 19 L/min (4.2 gallons/min)
Range	= 4.5-45 L/min (1-10 gallon/min)
Average Specific Capacity	= 5 L/min/m (0.36 gallons/min/foot)
Range	= 0.15-35 L/min/m (0.01-2.35 gallon/min/foot)

The average penetration of the wells into the shale is about 6-10 m (20-30 feet) and the apparent transmissivity of the shale is in the order of 7 m^2/day. The water quality of the one sample tested was within the drinking water guidelines except for an elevated chloride value of 89 mg/L. The water quality within the shale may well deteriorate with increased penetration, particularly with respect to chloride concentration.

3.2.3 GRANULAR OVERBURDEN:

Much of the old village core, as well as the one communal well, obtain water from within the granular soils present in the buried valley. The relevant well yield data for this aquifer are presented below:

Average Yield	= 64 L/min (14 gallons/min)
Range	= 14-173 L/min (3-33 gallons/min)
Average Specific Capacity	= 28 L/min/m (1.9 gallons/min/foot)
Range	= 1.3-75 L/min/m (0.09-5.0 gallons/min/foot)
Average Thickness	= 18.4 m (60.5 feet)
Range	= 7.6-38 m (25-124 feet)

The communal well, which supplies the Campbell subdivision, is developed in the overburden soils at a depth of 15 m. There is also a standby well, equipped with a small pump, developed at a depth of 22 m. A pumping test was carried out on the shallower well in 1973. The results indicated that the aquifer will support a perennial yield of 227 L/min (50 gallons/min) and that the transmissivity probably ranges between 575-760 m^2/day (38,500-50,800 gallons/day/foot).

The chemistry analyses of the four water samples obtained from overburden wells indicate that, with the exception of a somewhat elevated chloride and sodium content, the quality is within provincial guidelines for drinking water. The Region has been monitoring the quality of the water from the communal well on a regular basis and the results

indicate that the chloride and sodium content of the ground water in this aquifer is gradually increasing. The chloride content has reached in excess of 100 mg/L at times and the sodium content is in the order of 45 mg/L. The Ministry of the Environment recommended maximum chloride content for drinking water is 250 mg/L. There is, at present, no Ministry guideline for sodium content. However, data from the public health field suggests that sodium may be the more important parameter with regards to health. From the public health aspects, 20 mg/L of sodium in drinking water is the suggested level for people on low sodium diets. The few chemical analyses obtained during this study indicate that the elevated chloride and sodium content is present throughout the granular aquifer. The cause of the elevated chemical content was not determined during this study, however, one possible source may be winter road-salting practices along Highway 401. The chloride and sodium content of ground water from the Town of Milton well-field at Kelso, which is also in the granular aquifer, downgradient from Campbellville, is well below that from the Campbellville well. This indicates that there is sufficient ground water dilution available down-gradient from Campbellville to minimize the impact of the elevated chlorides and sodium on the Kelso well-field.

3.2.4 AQUIFER RECHARGE:

As suggested in section 3.1.1, we estimate that in the order of 150 mm of precipitation will infiltrate through the soils to the water table and recharge the aquifers, on an annual basis. this is equivalent to an average ground water recharge of approximately 4 m^3/day/ha (356 gallons day/acre).

In those areas where the overburden is relatively thin, as in the north of Highway 401, the infiltration will recharge the dolostone aquifer directly. In the areas of deeper soil cover, the precipitation will recharge the overburden aquifer. As stated previously, the general ground water flow direction is toward the buried valley. Along the flanks of the valley, there will be ground water leakage out of the dolostone aquifer into the granular aquifer. The volume of ground water underflow, both in the dolostone and granular aquifer will vary throughout the area, being dependent on hydraulic permeability, hdyraulic gradient and saturated thickness. For the dolostone aquifer, where ground water flow occurs in an irregular array of fractures, bedding planes and solution cavities, the interconnectivity of these passages is also a major factor governing the amount of ground water underflow. Within the granular aquifer in the buried valley, ground water flow will generally be "down-valley", towards the Kelso well-field. Obviously, the Campbellville area forms part of the ground water recharge area for the Kelso well-field. The contribution to the Kelso well-field from the dolostone aquifer to the north of Campbellville has been estimated by others to be in the order of 9100 m^3/day (2 million gallons/day).

3.3 Existing Residential Development and Ground Water Usage:

In 1979 the population of Campbellville was approximately 430. Some additional development has taken place in the McClaren subdivision since then. With the exception of the Campbell subdivision, which is serviced by a communal well, the area is serviced by individual wells. The results of the well record analysis and the house survey

indicate that the wells provide sufficient water for domestic purposes. Both the dolostone and overburden aquifers have the potential to supply moderate capacity wells. The Mohawk raceway has two bedrock wells rated at 450 and 510 L/min (100 and 112 gallons/min) and the communal well developed in the granular aquifer is rated at 227 L/min (50 gallons/min).

Current sewage disposal practices range from dry well to conventional septic tank and tile field. This does not appear to have impaired the quality of the gound water. With the exception of a relatively high chloride and sodium concentrations in the overburden aquifer, the ground water is at present quite acceptable for all domestic purposes.

3.4 Sewage Disposal by Commercial Development:

The three commercial developments located north of Highway 401, that is Mohawk Raceway, Mohawk Inn and K.O.A. Campgrounds, all dispose of their sewage wastes on-site. The Mohawk Raceway discharges sewage directly to a lagoon located in the southern part of the property. A second lagoon was constructed but is not used. (See Figure 4). The lagoon in use discharges into the wetland area located immediately to the south. It is also quite likely that some degree of exfiltration of liquid occurs from the base of the lagoon into the underlying soil. The depth of soil cover over the dolostone bedrock in this area is apparently thin and any liquid entering the soil would quickly reach the bedrock ground water system.

The Mohawk Inn also discharges sewage directly to a smaller lagoon located a short distance west of the Inn. This lagoon discharges very occasionally in the spring to a drainage ditch on the south side which ultimately goes beneath Highway 401. As with the Raceway lagoon, some degree of leakage out of the base of the Inn's lagoon probably occurs. We understand that the Mohawk Inn is undergoing a major expansion program which will effectively quadruple the volume of sewage wastes produced. We also understand that a lagoon will still be used as a receiving body for the final effluent.

The K.O.A. Campground disposes of sewage wastes by means of a septic tank and tile field system located immediately south of the washrooms. A second tile field is proposed for the planned expansion of the campgrounds, to be located in the lower lying lands east of the campsites.

The Raceway and Inn, and to a lesser extent the Campgrounds, are situated in an area where fairly shallow soil cover overlies the dolostone bedrock. These lands form part of the ground water recharge area for the dolostone aquifer in the hamlet. Consequently, any contaminants which enter the ground in this recharge area will migrate to the water table and mix with the ground water flow system. With regard to sewage, the chemical constituents which are of concern are principally nitrate nitrogen and chloride. Bacteria are not normally a problem as they are usually removed in the unsaturated zone or within a very short distance from the source. Nitrate nitrogen and chloride, however, can move in the ground water flow system quite readily. Provincial water-quality guidelines for drinking water for these two chemicals are 10 mg/L maximum for

nitrate nitrogen and 250 mg/L for chloride.

The principal method for attenuation of these two contaminants is dilution by mixing with "fresh" ground water from infiltrating precipitation or ground water underflow.

The results of this study indicate that the general ground water flow direction in this area is from the commercial development towards Campbellville. Based entirely on the available information, that is, estimated sewage volumes and concentrations, full leakage from the base of the lagoons to the ground water, estimated ground water underflow and recharge by infiltration of precipitation, we find that there may not be sufficient dilution of the contaminants by the ground water to bring the concentration of nitrate nitrogen to within the provincial guidelines at the northern boundary of the hamlet.

It should be emphasized that the preceding statement is based on our analysis of the existing information. In order to define the existing situation more completely, it will be necessary to undertake a full hydrogeological investigation, including subsurface drilling and ground water sampling. Only in this manner will it be possible to determine whether there is, or is not, an existing problem and what the potential is for a problem to develop in the future.

4.0 FUTURE DEVELOPMENT:

The Region requires that whatever future development occurs within Campbellville does so without detriment to the existing residents or community as a whole. From a purely hydrogeological viewpoint, this means that the increase in both ground water extraction and volume of sewage effluent disposed of into the ground, generated by future development, must not adversely impact on the supply or quality of ground water utilized by existing residents. Also, since the Campbellville area forms part of the ground water recharge area for the Kelso well-field, which supplies the Town of Milton, future development within Campbellville must not adversely impact this ground water source.

Essentially two routes are available for future development in Campbellville. The first route is to allow development based on individual wells and septic systems. The second route is to provide a communal water system to supply the entire hamlet and again utilize individual septic systems for sewage disposal. The Region requires that one communal system supply the entire hamlet rather than smaller systems for individual developments, because of the inherent problems in maintaining numerous small systems. The Rural Servicing Study completed by Underwood McLellan Limited in 1979 recommended that future growth in Campbellville be serviced by a communal water system.

4.1 DEVELOPMENT USING INDIVIDUAL WELLS:

The average daily indoor water requirement for a four-person household is in the order of 1.6 cubic metres (360 gallons), allowing a fifty percent contingency. Considering that much of this water is used over fairly short periods in the morning and evening, an individual well should be capable of providing a continuous output of between 4.5-9 L/min (1-2 gallons/min) to be considered as an adequate domestic supply. The above figures assume that the system includes a conventional storage tank.

Summer lawn and garden watering practices can place a much greater peak demand on the water supply system. Figures available indicate that peak demands can often exceed 27 L/min (6 gallons/min).

Analysis of the well yields for both the dolomite and overburden aquifers indicates that the average well yield is about 60 L/min (13 gallons/min). The average yield for the shale aquifer is 19 L/min (4.2 gallons/min). Thus, from a ground water yield viewpoint, the probability is high that individual wells, capable of providing an adequate domestic water supply, can be developed in any of the three aquifers within the Hamlet of Campbellville.

4.1.1 GROUND WATER AVAILABILITY AND LOT SIZE:

As stated previously, the indoor daily water requirement for a four person household is about 1.6 cubic metres (360 gallons), or 584 cubic metres (131,400 gallons)

annually. Summer irrigation practices have been estimated to account for about 170 cubic metres (37,400 gallons) annually. A third requirement on the ground water supply is that sufficient ground water be available on-site to dilute potential concentration of the contaminants that may be present in the sewage effluent, principally nitrate nitrogen, and to a lesser extent, chloride, to within provincial drinking water guidelines. Individual households produce approximately 1.1 cubic metres (240 gallons) of sewage effluent per day. The probable nitrate nitrogen concentration of the effluent below the tile field is in the order of 40 mg/L, and the drinking water guideline maximum is 10 mg/L. Consequently, in order to dilute the nitrate nitrogen in the effluent to within the guidelines, to say 7.5 mg/L, a volume of 4.8 cubic metres (1050 gallons) per day of "fresh" ground water is required. Annually this will total 1750 cubic metres (3.85×10^5 gallons) of ground water.

Thus, the total annual ground water requirement of an individual household is going to be in the order of 2500 cubic metres (5.5×10^5 gallons).

The lot size, therefore, will be governed by the availability of ground water to supply the above needs. In order not to deplete the aquifer, that is, not remove water from storage, ground water withdrawal should not exceed ground water recharge. As stated earlier, ground water recharge occurs from both infiltration of precipitation and ground water underflow in the Campbellville area. Thus, from a ground water requirement viewpoint, the

calculated minimum lot size required is in the order of 0.6 ha (1.5 acres). An additional buffer will be provided by requiring that this be a net area for each lot.

At this density, future development should not adversely impact on the existing community with regard to the quantity and quality of the ground water supply. Also, development at this density should not significantly impact on the Kelso well field either in the quantity or quality of ground water recharge originating in the Campbellville area.

From a purely hydrogeological viewpoint within the existing hamlet, phasing of development is not required.

It should be noted that whereas future development based on individual wells should not adversely impact the ground water supplies of the existing community, the water quality in the overburden aquifer is already somewhat impaired by a relatively high chloride and sodium content. Also, the indications are that the concentration of these two parameters is slowly increasing with time. Thus, the quality of water from the existing communal well should continue to be monitored. In light of this, it may well be preferable to instigate the search for a new communal well to supply the entire community.

4.1.2 IMPACT OF COMMERCIAL DEVELOPMENT ON GROUND WATER QUALITY:

As discussed in section 3.4, there is a concern over the potential impact of the sewage disposal practices of the commercial development, situated north of Highway 401, on the local ground water quality. This concern is of particular importance to the future development planned in the northwest quadrant of the hamlet. If this development proceeds on the basis of individual wells, then the question of whether there is, or is not, a potential for serious ground water contamination, either now or in the future, should be resolved.

4.1.3 HYDROGEOLOGICAL TESTING REQUIREMENTS:

Prior to future subdivision development proceeding, the local hydrogeologic conditions should be confirmed. Field testing should be carried out to define the soil and bedrock stratigraphy general direction of ground water movement, local aquifer and well yields and potential for well interference problems to develop with the existing development. Also, where possible, the individual well supplies should be confirmed prior to construction of the tile field. In this way, the maximum separation between the well and the tile field may be achieved in line with the Ministry of Environment guidelines.

4.2 Development Using A Communal Water System:

The Ministry of the Environment recommends that for rural communal water systems, 4.5 L/min (1 gallon/min) continuous production be provided per lot, where unrestricted outdoor watering will be permitted. The peak demands should be provided from storage facilities and high lift pumping equipment should be sized to satisfy these peak demands.

It is likely that where a communal system is implemented, fire protection facilities will also be installed. The Insurers Advisory Organization suggests that a minimum flow of 1800 L/min (400 gallons/min) be provided for a two hour period. This quantity can be provided either by the production wells or from storage facilities. The production wells should at least be able to refill the storage reservoir within an eight hour period. This corresponds to a well production capacity of at least 450 L/min (100 gallons/min) over and above the domestic requirements.

Thus, the total water requirement for a communal system is 450 L/min, plus 4.5 L/min per lot. In order to safeguard the aquifer, this water should not exceed the recharge capability of the natural system. For the existing Hamlet of Campbellville of say 120 lots, a communal water system with fire protection facilities would require a production of 990 L/min (220 gallons/min).

Figures available from the Town of Milton Planning Department indicate that Campbellville may ultimately attain a population of about 950 persons. This represents an increase

of some 130 residences, the water requirement of which would be 585 L/min (130 gallons/min). Thus, a communal water system to supply the existing community and all future development may require a production capability of 1575 L/min (350 gallons/min).

The existing communal well is capable of supplying 227 L/min (50 gallons/min) to the Campbell subdivision. However, since the water quality appears to be slowly deteriorating, it may become necessary to mix this water with water from the new communal well. We understand from the Public Works Department that this may be a costly exercise since the present system is not capable of pumping water beyond the existing subdivision boundaries. Consequently, we suggest that if a new communal well supply is proposed, it be designed to supply the entire community including the Campbell subdivision and have a capacity in the order of 1575 L/min.

4.2.1 SUGGESTED LOT SIZE:

The preferred location of the production wells for a communal system is outside the general hamlet boundary. Thus, within the hamlet itself, the hydrogeological factor controlling the lot size will be the ability of the ground water beneath the lot to dilute the sewage effluent to within provincial guidelines. This will safeguard the quality of ground water within the aquifer for those users located downgradient. It should also be remembered that the existing communal well, located within the hamlet, may or may not be integrated into a communal system at some point in the future. Thus, the long-

term protection of ground water quality is imperative. By assuming that both infiltration and ground water underflow can be used to dilute the sewage effluent to below the Provincial guideline maximum, the recommended minimum lot size is calculated to be 0.3 ha (0.75 acres). Again, in order to provide an additional buffer, this lot size should be considered as a net area.

4.2.2 LOCATION OF PRODUCTION WELLS:

The Ministry of the Environment requires that at least two operating wells must be constructed in order to provide the required water supply. Also, the capacity of the alternate or standby well should be at least twenty-five percent of the total production requirement.

Ultimately, an additional communal supply of 1575 L/min (350 gallons/min), may be required. On the information available, the best probability for obtaining a supply of this magnitude is within the dolostone aquifer.

Two wells at Mohawk Raceway are rated at 450 L/min and 510 L/min (100 and 112 gallons/min). Within Campbellville, the dolostone is present in the northwest and southwestern quadrants. However, the presence of the commercial development upgradient, immediately north of Highway 401, with its potential to impact local ground water quality, effectively rules out the northern portion of the hamlet as a suitable location for high capacity production wells. The capacity of the dolostone in the southwest to sustain high ground water extraction rates over the long term is unknown at this stage.

It seems reasonable therefore, to begin the search for a suitable location for the production wells in the area north of the hamlet, upgradient from possible sources of contamination and where it is known that high capacity wells can be developed. Also, from the data available, it appears that the Mohawk Raceway may be using approximately only fifty percent of its production capacity. Consequently, it may be possible to integrate part of their well capacity and storage facilities into the communal system, provided all necessary approval can be obtained. With regard to the quality of ground water likely to be encountered in the dolostone aquifer, the data available indicates that it should be well within Provincial guidelines for drinking water.

4.2.3 POTENTIAL IMPACT ON TOWN OF MILTON WATER SUPPLY:

Exclusive of the fire protection facilities, the total annual water requirement for Campbellville, including outdoor watering, is likely to be in the order of 192,000 cubic metres (42 million gallons). Considering only aquifer recharge from infiltration, this represents the annual recharge from an area approximately two-thirds the size of the hamlet. Since the recharge basin for the Kelso well field includes the areas to the north, west and south of the village, as well as the actual hamlet and lands to the east, the impact on the Kelso field of additional ground water extraction north of Campbellville is expected to be minimal.

4.2.4 HYDROGEOLOGICAL TESTING REQUIREMENTS:

Prior to making the commitment to provide a communal system, it may be advisable to undertake a long-term pump test on the Mohawk Raceway wells in order to

ascertain accurate hydraulic parameters for the dolostone aquifer in this area. Such a pump test should provide values for aquifer transmissivity and storage together with radius of influence of the pumping well and long term aquifer yield. Based on this data, it should then be possible to undertake a drilling program to locate the production wells for the communal system. It should be noted that since ground water flow within the dolostone occurs along interconnected fracture planes, solution cavities and bedding planes, it cannot be guaranteed that suitable production wells can be located. Subsurface exploration for suitable well sites may be time consuming and costly.

5.0 CONCLUSIONS:

1. The Hamlet of Campbellville and its environs are underlain by basically granular-type soils. A bedrock valley passes under the Hamlet and extends eastward towards the Kelso Reservoir. Bedrock on either side of the valley is dolostone and it is generally within about 7 or 8 m from surface. The buried valley itself is more than 40 m deep and is underlain by shale bedrock.

2. Ground water appears to flow into the buried valley from the lands surrounding it. These assumed flow directions are shown on Figure 6.

3. There are three main ground water aquifers within the study area. Granular materials that infill the bedrock valley provide a major source of ground water supply and form one of these aquifers. A number of private wells and the communal well, which services the Campbell subdivision, are developed in this aquifer. The dolostone bedrock, which is near ground surface north and south of the buried valley, forms the second major aquifer. Yields in both the dolostone and the buried valley average about 60 L/min (13 gallons/minute). The third aquifer is the shale bedrock that underlies the buried valley. Here, yields are considerably less than in the other two aquifers (19 L/min or 4.2 gallons/min).

4. Recharge to the dolostone aquifer occurs as direct infiltration of precipitation and as ground water underflow within the aquifer itself. Recharge to the buried valley aquifer occurs as infiltration and leakage from dolostone along the flanks of the buried valley.

5. The water quality in both aquifers is apparently within the Provincial guidelines for drinking water. However, the chloride and sodium content, of the granular aquifer in general, and the communal supply in particular appears to be slowly increasing.

6. The aquifers within the study area should provide adequate water supplies for future developments, with the following conditions.

a) In order to provide proper dilution of nitrates from septic systems, the density of development utilizing individual wells should be a minimum of 0.6 hectares (1.5 acres) net area per lot. Should a communal well be used then the net lot size could be reduced to a minimum of 0.3 hectares (0.75 acres). The total ground water recharge to the Kelso (Town of Milton) well-field downgradient to the east should not be endangered by this development density within the Hamlet of Campbellville.

b) Future sewage disposal practices of the commercial developments north of Highway 401 could have a potential impact on existing or future wells developed in the Hamlet of Campbellville immediately downgradient from these disposal areas.

c) If a communal well is developed, then it should be located within the dolostone aquifer upgradient (to the north) of the commercial sewage disposal areas. The total requirements for a communal system capable of servicing a population of about 950 persons would be in the order of 1575 L/min (350 gallons/min). Operational constraints may not allow the existing communal well to be incorporated into a new system.

d) The quality of the groundwater in the granular aquifer, with respect to chloride and sodium content does not rise above Provincial guidelines. Should this occur, then an alternative water source may be required for those wells developed in this aquifer.

6.0 RECOMMENDATIONS:

Based on the results of this preliminary ground water evaluation, we respectfully make the following recommendations.

1. If development is to be allowed based on individual wells, further, more detailed hydrogeological studies should be carried out in the northwest quadrant of the Hamlet and the area immediately north of Highway 401. The potential impact of the sewage disposal practices of the commercial development in this area, on the local ground water quality should be determined prior to development proceeding in this quadrant.

2. Elsewhere within the Hamlet, future subdivision development should proceed only after site specific hydrogeologic conditions have been confirmed. Field testing should define soil and bedrock stratigraphy, direction of ground water movement, aquifer and well yields, water quality and potential for well interference problems with existing development.

3. Individual water supplies should be sited according to MOE guidelines and confirmed prior to construction of the tile field in order that maximum separation between the well and the tile field may be achieved.

4. The water quality monitoring program undertaken by the Region at the existing communal well should continue, with particular attention paid to the chloride and sodium content.

5. If future development is to proceed based on provision of a communal water supply for the entire hamlet, then substantial hydrogeologic investigations will be required to locate and evaluate a suitable supply. Such a study should confirm aquifer parameters, and determine the long-term acceptability of the ground water source for both quantity and quality.

6. In order to provide proper dilution of nitrates from septic systems, the density of development utilizing individual wells should be a minimum of 0.6 hectares (1.5 acres) net area per lot. Should a communal well be used, then the net lot size could be reduced to a minimum of 0.3 hectares (0.75 acres).

APPENDIX 1

MOE Water Well Data - Table 1

Summary of Water Well Data - Table 2

Water Chemistry Results - Table 3

Water Budget and Climate Data - Figure 3

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 1

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1754	Baker, L. C2L3	958	6/65	4	70	30	33	10	3.33	Do	0-26 - clay stones 26-75 - grey limestone
1756	Livingstone, S.E. C2L4	953	12/67	5	50	19	20	10	10.0	Do	0-23 - clay limestone gravel 23-28 - limestone clay 28-60 - grey limestone
3881	Mathies, A.F. C2L5	965	6/72	6	34 36	12	14	15	7.50	Do	0-31 - brown clay gravel silt 31-37 - grey clay gravel
5074	Day, R. C2L8	1004	6/77	6	36 56 62	16	43	17	0.63	Do	0-4 - brown sand clay 4-62 - grey limestone
5094	Lawrynowicz, J. C2L9	1050	8/77	6	62 81	55	76	15	0.71	Do	0-25 - brown clay gravel, loose. 25-35 - brown clay boulder, loose. 35-85 - grey limestone, hard.
5063	Perry, J. C3L3	990	3/77	6	36 43	25	36	20	1.82	Do	0-16 - brown clay gravel boulder. 16-49 - grey limestone.
1821	Currie, C. C3L3	995	2/59	6	45	33	57	6	0.25	Do	0-35 - preduo 35-37 - medium sand 37-57 - grey limestone
1822	Deforest, B. C3L3	990	3/59	6	49 61	28	38	3	0.30	Do	0-2 - topsoil medium sand 2-37 - gravel boulder 37-62 - grey limestone
5166	Hemrica, C. C3L4	970	4/77	6	18 28	5	5	40	-	Do	0-16 - brown clay sand gravel 16-30 - grey limestone.

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 2

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1828	Holmes, L. C3L4	985	4/66	6	35	26	48	2	0.09	Do	0-11 - clay boulder 11-48 - limestone
4643	Reed, G. C3L4	988	11/74	6	58	47	56	10	1.11	Do	0-19 - brown sand stones 19-43 - brown rock 43-65 - grey limestone
1826	Dales, R. C3L4	1010	8/62	5	63 72 75	47	50	8	2.67	Do	0-8 - clay 8-27 - gravel stones clay 27-80 - grey limestone
1827	Burnett, D.T. C3L4	1003	11/62	6	50	31	53	10	0.83	Do	0-32 - medium sand boulder 32-68 - grey limestone
1824	Marsh, F. C3L4	990	8/59	6	38	26	44	5	0.28	Do	0-19 - topsoil medium sand 19-44 - grey limestone.
1823	Cross, W.M. C3L4	995	7/59	7	36	31	38	10	1.43	Do	0-28 - topsoil medium sand boulder. 28-50 - grey limestone.
1825	Davies, W. C3L4	990	12/59	6	45	31	45	2	0.14	Do	0-3 - fill 3-26 - topsoil medium sand 26-47 - grey limestone
2887	Bonsfield, N. C3L5	950	2/68	6	25 29	4	7	30	10.0	Do	0-23 - brown medium sand gravel. 23-31 - grey limestone
3831	Agnew, D. C3L5	965	5/72	6	20 22	9	33	15	0.63	Do	0-22 - brown silt gravel 22-25 - grey clay gravel 25-42 - grey limestone
1830	Currie, M. C3L5	948	9/58	6	103	35	50	10	0.67	Do	0-40 - topsoil medium sand 40-100 - clay gravel medium sand. 100-105 - blue limestone.

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 3

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4203	Lions Club C3L5	940	4/73	6	44	19	72	5	0.09	Do	0-33 - brown silt gravel boulders 33-48 - red sand 48-69 - brown sand gravel 69-75 - brown sand gravel clay 75-77 - blue clay
1831	Brown, G.D. C3L5	970	12/62	6	85	45	80	3	0.09	Do	0-25 - clay medium sand stones 25-80 - clay medium sand 80-83 - medium sand 83-87 - medium sand gravel 87-105 - clay 105-112 - grey shale 112-115 - red limestone
1829	Mitchell, L. C3L5	970	9/53	5	67	32	57	4	0.16	Do	0-3 - topsoil 3-5 - gravel clay 5-46 - red clay 46-48 - grey clay 48-51 - gravel clay 51-68 - blue limestone 68-87 - grey limestone 87-89 - red shale
1844	Hull, L. C3L6	952	8/59	7	30 35	15	25	20	2.00	Do	0-15 - topsoil 15-25 - medium sand gravel 25-30 - gravel stones 30-36 - limestone
4211	Burt, D. C3L6	950	4/73	6	15	11	17	24	4.00	Do	0-15 - brown silt gravel boulder 15-21 - brown sand gravel 21-41 - grey limestone

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 4

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1833	Parker, R. C3L6	945	6/52	6	36	18	18	4	-	Do	0-35 - gravel medium sand 35-38 - limestone
1845	Inglis, G. C3L6	945	12/63	6	35 38	7	14	20	2.86	Do	0-27 - medium sand gravel 27-40 - grey limestone
1843	Inglis, D. C3L6	945	8/59	5	45	15	35	20	1.00	Do	0-25 - topsoil, medium sand gravel 25-35 - medium sand gravel boulder 35-47 - limestone
4734	Parker, J. C3L6.	954	4/75	6	30	12	33	10	0.48	Do	0-35 - brown sand silt 35-41 - grey clay
1832	Early, R. C3L6.	955	11/49	4	79	30	-	2	-	Do	0-47 - clay gravel 47-79 - red shale
3106	Evans, C. C3L6	962	6/69	6	62	34	45	10	0.91	Do	0-30 - brown clay stones 30-52 - brown clay gravel 52-59 - shale gravel 59-62 - gravel
2865	Gwillimbury Land-fills Dev. C3L6	960	4/63	6	59	30	55	7	0.28	Do	0-25 - brown clay stones. 25-55 - brown clay gravel. 55-60 - brown medium sand gravel. 60-64 - red shale 64-75 - blue shale 75-90 - red shale
1842	Reid, J. C3L6.	951	10/58	6	35	22	30	12	1.50	Do	0-30 - clay gravel 30-35 - gravel stones

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 5

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
3427	Mixed C3L6	960	9/70	6	70	71	76	5	1.00	Do	0-30 - brown clay stones 30-55 - brown silt gravel 55-58 - medium sand gravel 58-64 - red shale gravel 64-76 - shale rock 76-78 - blue shale rock
1847	Mahon, J.K. C3L6	950	8/67	6	30	22	30	20	2.50	Do	0-42 - gravel boulder 42-53 - grey limestone 53-54 - blue shale
1839	Capins, E. C3L6.	950	5/58	5	45	5	15	20	2.00	Do	0-28 - topsoil medium sand 28-34 - boulder 34-50 - limestone
2880	Lush, W.H. C3L6	955	6/68	6	31 58	25	66	2	0.05	Do	0-5 - fill 5-58 - gravel medium sand 58-63 - blue clay gravel 63-66 - red shale
1846	Woods, W. C3L6	945	1/66	6	30	19	30	15	1.36	Do	0-20 - medium sand boulder 20-39 - medium sand boulder gravel 39-55 - gravel
1834	McPhedian, K. C3L6.	935	9/52	6	38	22	22	5	∞	Do	0-40 - gravel
1840	Inglis, D. C3L6	944	5/58	6	73	30	70	1	0.03	Do	0-60 - clay medium sand gravel 60-70 - boulder medium sand gravel. 70-75 - red shale
1837	Early, P.J. C3L6	939	5/55	6	40	15	20	20	4.00	Do	0-8 - preduq 8-30 - medium sand 30-44 - gravel

PROJECT 81-126 WATER WELL DATA TABLE 1 SHEET 6

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1836	Mahon, E.D. C3L6	940	4/55	4	52 72 75	25	40	3	0.20	Do	0-3 - topsoil 3-23 - clay gravel 23-40 - gravel 40-52 - limestone 52-79 - blue shale
1835	Crawford, L. C3L6.	940	4/55	4	70 75	12	22	8	1.00	Do	0-4 - topsoil 4-20 - gravel clay 20-46 - medium sand 46-60 - clay 60-79 - blue shale
1838	McCarthy, P. C3L6.	935	5/58	6	73	16	70	1	0.02	Do	0-40 - clay stones 40-58 - medium sand gravel 58-75 - red shale
1851	Day, B.G. C3L7	950	6/66	5	35 50	19	55	24	0.67	Co	0-1 - topsoil 1-4 - brown clay stones 4-12 - brown limestone 12-56 - grey limestone 56-60 - blue shale
1849	Day, B.G. C3L7	950	6/66	5	30	18	-	18	-	Co	0-1 - topsoil 1-8 - brown clay stones 8-20 - brown limestone 20-55 - grey limestone 55-60 - shale
1850	Sun Oil Co. Ltd. C3L7	962	6/66	5	30	12	55	8	0.19	Co	0-1 - topsoil 1-6 - fine sand 6-10 - gravel 10-18 - brown limestone 18-56 - grey limestone 56-60 - blue shale

PROJECT 81-126 **WATER WELL DATA** TABLE 1 SHEET 7

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1852	Day, B.G. C3L7	950	9/66	5	58	29	-	1	-	Co	0-1 - topsoil 1-6 - brown clay stones 6-35 - brown limestone 35-54 - grey limestone 54-58 - blue shale 58-65 - red shale
1841	Sharpe, K.C. C3L7	934	10/58	6	50	10	30	15	0.75	Do	0-30 - clay gravel 30-40 - medium sand gravel 40-50 - gravel
3846	Day, D.G. C3L7	985	5/72	5	45	11	35	25	1.04	Do	0-1 - topsoil 1-25 - brown clay stones 25-29 - brown clay gravel 29-65 - grey rock 65-88 - grey rock 88-91 - blue shale
3845	Day, D.G. C3L7.	1000	5/72	5	55	8	20	25	2.08	Do	0-1 - brown topsoil 1-10 - brown clay stones 10-45 - red clay gravel 45-86 - grey rock 86-89 - blue shale
4853	Hacker C3L7	952	4/76	5	55	7	30	20	0.37	Co	0-9 - brown clay stones 9-18 - brown rock 18-57 - grey rock 57-58 - blue shale
1851	Day, B.G. C3L7	950	6/66	5	35 50	19	55	24	0.67	Co	0-1 - Topsoil 1-4 - brown clay stones 4-12 - brown limestone 12-56 - grey limestone 56-60 - blue shale

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 8

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
3846	Day, D.G. C3L7	985	5/72	5	45	11	35	25	1.04	Do	0-1 - topsoil 1-25 - brown clay stones 25-29 - brown clay gravel 29-65 - grey rock 65-88 - grey rock 88-91 - blue shale
3845	Day, D.G.	1000	5/72	5	55	8	20	25	2.08	Do	0-1 - brown topsoil 1-10 - brown clay stones 10-45 - red clay gravel 45-86 - grey rock
4853	Hacker C3L7	952	4/76	5	55	7	30	20	0.87	Co	0-9 - brown clay stones 9-18 - brown rock 18-57 - grey rock 57-58 - blue shale
1848	Day, B.G. C3L7	960	6/66	5	---	---	DRY	---	---	---	0-1 - topsoil 1-23 - brown clay stones 23-30 - brown limestone 30-59 - grey limestone 59-80 - blue shale
1853	Day, B.G. C3L7	958	9/66	5	---	---	DRY	---	---	---	0-1 - topsoil 1-5 - brown clay stones 5-32 - brown limestone 32-40 - grey limestone 40-48 - brown limestone 48-53 - grey limestone 53-57 - blue shale 57-60 - red shale

PROJECT 81-126 WATER WELL DATA TABLE 1 SHEET 9

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1854	Day, B.G. C3L7	956	9/66	5	58	29	158	1	0.01	Co	0-1 - topsoil 1-6 - brown clay stones 6-25 - brown limestone 25-56 - grey limestone 56-58 - blue shale 58-65 - red shale 65-96 - blue shale 96-100 - red shale 100-130- blue slate 130-153- grey limestone 153-156- blue shale 156-158- red shale
1855	Day, B.G. C3L7	956	10/66	5	53	28	34	23	3.83	Co	0-9 - brown clay stones 9-25 - brown limestone 25-53 - grey limestone 53-58 - blue shale 58-60 - red shale
1857	Mohawk Raceway C3L9	998	3/62	10	125	29	53	100	4.17	Co	0-5 - medium sand gravel 5-9 - white limestone 9-59 - brown limestone 59-135 - grey limestone 135-138- blue shale
1856	Mohawk Raceway C3L9	1002	4/62	10	21	8	24	112	7.00	Co	0-8 - clay medium sand boulder 8-87 - limestone 87-90 - grey shale 90-102 - brown shale
1859	Wood, W.H. C3L10	1025	8/60	6	49	21	52	4	0.13	Do	0-4 - brown topsoil 4-52 - grey limestone
1862	Wood, L. C3L10	1025	7/64	6	56	20	58	6	0.16	Do	0-37 - brown medium sand clay boulders 37-58 - grey limestone

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 10

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1866	Small, G.R. C3L12	990	11/63	6	46	21	48	5	0.19	Do	0-19 - brown clay gravel boulder 19-29 - grey clay boulder gravel 29-43 - blue clay gravel 43-48 - grey limestone
2877	Peace, E.C. C4L3	966	7/68	6	35	7	10	5	1.67	Do	0-12 - brown clay stones 12-50 - limestone
5067	Burge, H. Const. C4L3	964	4/77	5	46	10	40	12	0.40	Do	0-18 - brown clay 18-23 - grey limestone 23-27 - grey limestone sand 27-52 - grey limestone
2872	Copeland, J. C4L3	964	7/68	6	34 50	15	54	8	0.21	Do	0-10 - silt boulder 10-19 - limestone 19-54 - grey limestone
1899	Moore, K. C4L3	964	12/67	6	31 39	15	34	15	0.79	Do	0-9 - boulder silt 9-43 - grey limestone
4739	Sutherland, H. C4L3	962	1/75	6	47 55	10	42	5	0.16	Do	0-15 - brown clay stones 15-56 - grey limestone
4865	Vandendool, H C4L3	962	6/76	6	32 36	8	28	15	0.75	Do	0-2 - black silt 2-26 - brown clay sand 26-38 - limestone
5077	Higgins, R.R. C4L3	896	5/77	5	40 49	6	15	15	1.67	Do	0-12 - clay stones 12-25 - blue rock 25-35 - blue shale 35-50 - red shale
3301	Kennelly Const. C4L3	850	12/69	-	33	10	11	5	5	Do	0-23 - brown medium sand stones 23-35 - grey limestone

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 11

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4511	Zimmerman, H. C4L3	838	6/74	-	22	-	-	6	-	-	0-24 - brown sand gravel boulders 24-36 - red clay gravel sand 36-50 - red shale
4930	Skinner, J. C4L3	840	9/76	5	60	30	40	2	0.20	-	0-1 - brown topsoil 1-25 - brown clay stones 25-46 - red shale 46-60 - red shale 60-90 - red shale
4931	Skinner, J. C4L3	840	9/76	5	30	12	30	5	0.28	Do	0-1 - brown topsoil 1-25 - brown clay stones 25-28 - grey rock 28-55 - red shale
4753	Tuinstra Const. C4L4	970	7/75	6	26	10	17	15	2.14	Do	0-13 - brown sand boulder 13-30 - grey limestone
1905	Burrel Const. C4L4	975	5/66	6	25 35	18	23	12	2.40	Do	0-21 - predug 21-36 - limestone
4220	Robertson, H. C4L4	970	4/73	6	17 32	7	16	24	2.67	Do	0-8 - brown silt boulder 8-37 - grey limestone
3548	Batek, P. C4L4	962	4/71	6	12 28	11	34	15	0.65	Do	0-12 - brown clay boulder 12-41 - grey limestone
1903	Peterson, D. C4L4	943	11/63	6	53	12	55	2	0.05		0-15 - predug 15-30 - brown clay gravel boulder 30-36 - grey clay gravel 36-46 - red clay 46-55 - blue shale

PROJECT 81-126 **WATER WELL DATA** TABLE 1 SHEET 12

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1900	McMurray, J. C4L4	985	10'60	6	47	23	47	10	0.42	Do	0-22 - clay boulder 22-50 - limestone
1901	Hendrickson, C. C4L4	985	6/61	6	37	20	36	6	0.38	Do	0-19 - medium sand boulder 19-40 - grey limestone
2883	Laughton, F.W. C4L4	963	7/68	6	43	11	18	20	2.86	Do	0-8 - brown clay 8-19 - grey clay boulder 19-46 - grey limestone
1904	Harris, G. C4L4	978	4/66	6	21 29	4	8	10	2.50	Do	0-12 - clay boulder 12-30 - limestone
1902	Shell, K. C4L4	978	4/63	6	24 34	7	32	8	0.32	Do	0-9 - medium sand boulder 9-35 - limestone
1906	Dredge, J. C4L4	978	11/67	6	22 35	9	40	5	0.16	Do	0-8 - brown silt 8-40 - grey limestone
3661	Goldstraw, G. C4L4	972	8/71	6	29 39	12	39	12	0.44	Do	0-19 - brown silt boulder 19-42 - grey limestone
3148	Tonelli, H. C4L5	950	8/69	6	37	37	37	15		Do	0-33 - red silt boulder 33-54 - brown clay gravel
1907	Mahon, M. C4L5	980	6/65	6	58 105	65	75	10	1.00	Do	0-58 - brown medium sand clay 58-65 - brown medium sand 65-105 - clay medium sand 105-117- red quick sand 117-124- grey medium sand gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 13

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4235	Elamboro Centre Property C4L5	940	2/73	8	66	29	60	30	0.97	PS MU	0-15 - grey clay stones 15-30 - grey clay sand 30-53 - grey clay stones 53-60 - brown clay gravel hardpan 60-66 - brown clay 66-68 - brown gravel 68-73 - brown clay gravel
3695	Goldstraw, G. C4L5	940	11/71	8	41	26	26	15	∞	Do	0-20 - brown gravel clay medium sand 20-41 - brown gravel clay 41-45 - brown gravel 45-47 - brown gravel clay 47-49 - red clay gravel
4208	Mahon, M. C4L5	920	4/73	6	35	17	26	15	1.67	Do	0-6 - stores 6-27 - brown sand gravel boulder 27-35 - red sand clay silt 35-39 - red sand 39-54 - red sand gravel clay 54-60 - grey clay gravel
3142	King Calcium Products C4L5	878	7/69	6	15 16	3	3	16	∞	IN	0-15 - brown silt gravel 15-19 - red quick sand 19-36 - brown silt gravel 36-40 - red medium sand gravel 40-44 - grey gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 14

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4219	Mitchell, G. C4L5	870	6/73	6	14 60	10	62	8	0.15	Do	0-14 - brown sand boulder gravel 14-27 - brown silt 27-43 - brown sand clay gravel 43-60 - brown sand 60-68 - grey gravel clay
4769	Yackman, R. C4L6	950	7/75	6	47	47	47	12	"	Do	0-37 - brown sand gravel boulder 37-50 - brown gravel silt sand 50-58 - red clay gravel boulder
1917	William Arch Cons. C4L6	935	4/65	6	18	8	24	16	1.00	Ps	0-11 - silt boulder 11-31 - red medium sand gravel 31-60 - brown medium sand gravel 60-65 - red medium sand
4951	Beswick, A. C4L6	932	10/76	5	52	7	20	8	0.62	Do	0-1 - topsoil 1-20 - brown clay sand stones 20-30 - brown clay sand fine gravel 30-82 - brown clay sand coarse gravel 82-85 - brown clay sand fine gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 15

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1915	Currie C4L6	941	11/58	6	50	20	35	17	1.13	Do	0-35 - clay gravel 35-45 - medium sand gravel 45-50 - gravel
1921	Bell Telephone C4L6	940	11/67	5	67	20	25	12	2.40	Co	0-1 - topsoil 1-15 - clay stones 15-20 - red clay 20-49 - red clay stones 49-66 - medium sand gravel clay 66-67 - grey gravel
1912	Moore, K. C4L6	937	8/56	6	18	18	22	10	2.50	Do	0-26 - boulder medium sand 26-40 - gravel coarse sand
1913	Cramp, S. C4L6	950	9/58	6	59	29	35	15	2.50	Do	0-30 - topsoil medium sand 30-50 - medium sand 50-59 - gravel
3697	Robinson C4L6	930	11/71	6	33	19	23	15	3.75	Do	0-21 - predug 21-36 - brown gravel medium sand 36-38 - grey clay gravel
1919	Coulter, W. C4L6	950	9/65	5	61	30	33	10	3.33	Do	0-20 - gravel stones 20-59 - medium sand clay 59-61 - gravel
4742	Agnew, D. C4L6	940	5/75	6	18	6	47	15	0.37	Do	0-17 - brown sand boulder 17-38 - red sand 38-43 - brown gravel clay
3702	Herensberger, F. C4L6	950	1/72	5	58	13	20	10	1.43	Do	0-25 - brown clay stones 25-50 - brown clay sand gravel 50-58 - gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 16

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1908	Henderson, S. C4L6	930	7/55	6	60	18	50	8	0.25	Do	0-22 - medium boulder 22-58 - limestone 58-71 - red shale
1911	Mahon, R. C4L6	940	6/56	6	30 57	30	35	12	2.4	Do	0-47 - medium sand gravel 47-57 - gravel
1909	Black, L. C4L6	947	7/55	5	50	36	50	5	0.36	Do	0-17 - clay stones 17-21 - gravel 21-30 - red clay gravel 30-39 - blue clay 39-58 - red shale 58-70 - grey shale
1914	Vansickle, H. C4L6	939	9/58	5	63	34	80	1	2.35	Do	0-25 - predug 25-30 - red clay gravel 30-42 - gravel 42-81 - blue shale
5062	Elsebroek, J. C4L6	900	2/77	6	14	14	14	8	∞	Do	0-14 - predug 14-19 - brown sand 19-23 - brown gravel sand 23-26 - red clay gravel boulders 26-26 - red shale
1920	Benson, F. C4L6	900	10/65	6	36	20	24	20	5.0	Do	0-36 - medium sand boulder 36-42 - quick sand 42-49 - red medium sand gravel 49-55 - gravel clay
4516	Benson, F. C4L6	910	4/74	6	54	20	20	30	∞	St	0-21 - brown sand clay silt 21-57 - red silt sand 57-60 - red clay 60-64 - grey clay gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 17

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4513	Beaven, F. C4L6	905	5/74	6	52	20	20	30	∞	Do	0-19 - brown clay sand boulder 19-52 - red clay sand 52-57 - red sand 57-61 - red clay gravel 61-64 - grey clay gravel
1910	Mitchell, C.H. C4L6	890	8/55	7	40	40	-	10	-	Do	0-35 - medium sand boulder 35-55 - medium sand 55-67 - gravel 67-68 - shale
1916	Campbell Sand & Gravel C4L6	905	3/65	7	130	44	125	1	0.01	IN	0-17 - boulder gravel 17-29 - red clay 29-64 - gravel 64-70 - clay gravel 70-80 - limestone 80-84 - blue shale 84-134 - red shale
1918	Campbell Sand & Gravel C4L6	870	3/63	7							0-3 - fill 3-6 - gravel boulder 6-28 - red fine sand 28-32 - gravel medium sand 32-36 - fine sand 36-38 - boulder 38-39 - shale
1922	Campbell Sand & Gravel C4L7	945	3/63	7	10	4	25	10	0.48		0-20 - limestone 20-25 - blue shale 25-39 - red shale 39-65 - blue shale

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 18

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
4783	Loedige, A. C4L8	972	6/75	6	20	19	20	20	20.00	Do	0-10 - red clay sand stones 10-21 - grey limestone 21-48 - yellow limestone 48-71 - grey limestone 71-73 - yellow limestone 73-86 - grey limestone 86-91 - red shale 91-94 - grey shale 94-104 - red shale 104-113 - grey shale 113-120 - red shale
1923	Webb, W. C4L9	1000	10/58	6	45	30	40	8	0.80	St Do	0-28 - clay gravel 28-50 - limestone
3343	Pivka, G. C4L9	1005	4/70	5	105	30	40	10	1.00	Co	0-14 - gravel stones 14-105 - grey limestone
1924	Ichenberger, F. C4L10	1030	8/60	6	32	14	23	10	1.43	Do	0-29 - topsoil medium sand boulder 29-36 - grey limestone
5024	Banova Corp. Ltd. C5L3	854	2/77	6	65	19	30	10	0.91	St	0-1 - topsoil 1-15 - brown clay stones 15-25 - brown clay sand 25-35 - brown sand clay gravel 35-58 - brown fine sand 58-64 - brown rock 64-66 - gravel
955	Currie, D. C5L4	882	10/66	5	119	68	75	10	1.43	Do	0-30 - preduq 30-119 - medium sand 119-124 - gravel

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 19

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1968	Benzetti, T. C5L4	870	11/63	5	70	40	45	7	1.40	Do	0-40 - gravel 40-47 - blue clay 47-68 - clay medium sand gravel 68-70 - gravel
1967	Early, L. C5L4	870	1/63	6	61 78	45	78	3	0.09	Do	0-61 - medium sand boulder 61-78 - red quicksand
2885	Casarin, M. C5L4.	880	11/68	6	60	46	57	10	0.91	Do	0-27 - gravel boulder 27-39 - grey clay 39-68 - medium sand gravel
1966	Elliot, W. C5L4	870	11/61	6	32 40	22	33	8	0.73	Do	0-34 - gravel boulder 34-39 - blue clay 39-41 - gravel
3554	Stokes, J. C5L4	815	5/71	6	34	32	38	10	1.67	Do	0-20 - predug 20-34 - grey clay gravel 34-40 - red clay gravel 40-48 - brown medium sand gravel 48-55 - grey clay
1974	Campbell Sand & Gravel C5L5	870	12/64	2	14						0-6 - red clay gravel boulder 6-14 - gravel boulder clay 14-36 - gravel medium sand boulder 36-57 - gravel medium sand clay 57-63 - clay gravel 63-70 - red clay 70-73 - shale

PROJECT 81-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 29

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1975	Campbell Sand & Gravel C5L5	870	12/64	2	3						0-3 - medium sand gravel boulder 3-56 - medium sand gravel 56-80 - gravel medium sand 80-92 - gravel clay 92-93 - shale
1971	Campbell Sand & Gravel	870	11/64	2	61	15	19	38	9.5		0-3 - clay gravel boulder 3-5 - gravel clay 5-45 - gravel medium sand boulder 45-61 - clay silt medium sand 61-76 - fine sand coarse sand gravel 76-99 - gravel medium sand boulder 99-101 - red shale
1976	Campbell Sand & Gravel C5L5	870	11/64	2	16	16	21	40	8.00		0-5 - medium sand clay gravel 5-16 - fine sand silt gravel 16-48 - gravel medium sand boulder 48-53 - gravel boulder 53-99 - medium sand gravel 99-103 - red shale

PROJECT 81-126 WATER WELL DATA TABLE 1 SHEET 21

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
1973	Campbell Sand & Gravel C5L5	870	11/64	2	16						0-16 - clay gravel medium sand 16-46 - gravel medium sand boulder 46-67 - medium sand gravel 67-96 - gravel medium sand clay 96-101 - shale
1972	Campbell Sand & Gravel C5L5	870	11/64	1	35						0-1 - topsoil 1-10 - clay medium sand gravel 21-35 - fine sand silt gravel 35-44 - medium sand gravel 44-56 - fine sand coarse sand gravel 56-79 - medium sand gravel 79-84 - red clay gravel 84-96 - gravel clay 96-97 - shale
1977	Campbell Sand & Gravel C5L5	870	3/65	7	72	42	47	20	4.0	Co	0-1 - topsoil 1-15 - boulder clay 15-34 - gravel stones 34-45 - red clay 45-72 - fine sand 72-86 - gravel
1978	Boy Scout Camp C5L6	870	3/58	6	43	24	48	1	0.04	Do	0-22 - gravel boulder 22-28 - gravel 28-38 - medium sand 38-42 - shale 42-43 - blue shale 43-48 - red shale

PROJECT 31-126 **WATER WELL DATA** **TABLE** 1 **SHEET** 22

well no	name (owner) location	collar elev.	date	well dia.	water found	static level	pump level	pump rate	specific capacity	well use	well log
5061	Austin, R. C5L6	872	2/77	6	16 30	16	16	12	∞	Do	0-16 - predug 16-30 - brown gravel silt sand 30-32 - brown gravel 32-33 - brown gravel boulder
4803	Zapparolt, T. C3L3	1910	3/75	6	72	44	59	20	1.33	Do	0-10 - brown clay sand 10-15 - brown gravel boulder 15-27 - brown clay sand gravel 27-78 - grey limestone
5356	Sutherland, H. C3L5	980	04/79	6	52 74	30	65	6	0.17	Do	0-8 - brown sand 8-17 - sand and gravel 17-38 - brown sandy clay 38-76 - grey limestone 76-77 - red shale
5357	Trigiani C3L5	970	04/79	6	65	42	45	15	5.0	Do	0-40 - sand gravel boulders 40-54 - coarse sand 54-65 - grey limestone

SUMMARY OF WATER WELL DATA

TABLE 2

BEDROCK WELLS

AREA \ PARAMETER	PUMP RATE (gpm)		SPECIFIC CAPACITY (gpm per ft drawdown)		OVERBURDEN THICKNESS(ft)		DOLOMITE ONLY	DOLOMITE AND SHALE		SHALE ONLY
	Aver.	Range	Aver.	Range	Aver.	Range	Penetration into Dolomite (ft)	Dolomite Thickness (ft)	Penetration into Shale (ft)	Penetration into Shale (ft)
Overburden Less Than 25' Thick North of Hwy 401 wells generally penetrate through DOLOMITE into SHALE	13.0	1-24 (2 High values 100 gpm Raceway)	1.58	0.01-7	7.46	0-14	-	Aver.60.0 Rnge 20-130	Aver.19.4 Rnge 1-102	-
South of Campbellville Wells developed in DOLOMITE	13.3	2-40	1.73	0.09-10	15.7	8-25	Aver.25 Rnge 8-44	-	-	-
Overburden Greater Than 25' Thick South of Campbellville Wells developed in DOLOMITE	9.3	2-20	0.98	0.14-2.67	31.2	26-43	Aver.32.9 Rnge 12-53	-	-	-
Southwest corner of area & north of 401 Wells developed in DOLOMITE	13.3	4-20	1.8	0.16-3.3	32.5	26-43	Aver.18.8 Rnge 3-50	-	-	-
Campbellville & east of Campbellville Wells penetrate through DOLOMITE & are terminated in SHALE	5.2	1-10	0.26	0.01-0.67	31.8	10-70	-	Aver.17.3 Rnge 3-38	Aver.30.3 Rnge 13-54	
Campbellville & east of Campbellville dolomite is absent, wells are developed in SHALE	3.2	1-8	0.46	0.02-2.35	55.8	25-105	-	-	-	Aver.21 Rnge 9-65
Wells developed in OVERBURDEN	14	3-38	1.90	0.09-5.0	60.5	25-124	-	-	-	-

PROJECT 81-126

TABLE 3 SHEET 1

WATER ANALYSIS RESULTS

SAMPLING LOCATION CAMPBELLVILLE TESTED BY HEALTH UNIT TOOK SAMPLES, MOE ANALYSED SAMPLES

PROPERTY		Communal Well Overbur.	King Calcium Overbur	C.Evans Overbur.	Parcham Overbur.	Crawford Shale BR.	Mohawk Raceway Dolomite	Burt D. Dolomite				
CONDUCTIVITY μMHOS CM		MOE 3695 830	MOE 3142 790	MOE 3106 840	MOE1846 840	MOE 1835 880	MOE 1857 720	MOE 4211 700				
pH		7.46	7.42	7.77	7.30	7.27	7.27	7.32				
HARDNESS ($CaCO_3$)		336	342	344	344	352	400	376				
ALKALINITY ($CaCO_3$)		294	277	300	288	293	303	248				
CHLORIDES (Cl)		75.0	74	87	82	89	11.0	12.0				
SULPHATES (SO_4)		30	30	31	31	41	85	126				
PHOSPHOROUS AS P	Total											
	Soluble											
NITROGEN (N)	Total Kjeldahl	0.2	0.3	0.2	0.2	0.2	0.2	0.2				
	Free Ammonia	0	0	0	0	0	0	0				
	Nitrite	0	0.1	0.06	0.1	0.1	0	0.01				
	Nitrate	1.5	1.0	0.1	0.3	0.5	1.1	0				
Potassium (K)		1.3	1.1	1.7	1.6	1.9	5.5	1.5				
Magnesium (Mg)		30	34	26	27	29	40	32				
Calcium (Ca)		85.0	81.0	94	88	93	94	98				
Sodium (Na)		47.5	34.0	45.5	41.5	47.5	5.5	8.0				
Iron (Fe)		0.02	0.01	0.85	0.1	0.04	0.02	1.84				
Total Dissolved Solids		495	490	475	515	535	470	475				
Dissolved Organic Carbon		0.8	0.4	1.0	0.5	0.8	0.8	0.4				
Manganese		0.008	0.0002	0.30	0.004	0.002	0.014	0.024				

NOTE: concentrations in p.p.m. unless otherwise noted.

Gartner Lee Associates Limited

PROJECT 81-126

TABLE 3 SHEET 2

WATER ANALYSIS RESULTS

SAMPLING LOCATION CAMPBELLVILLE TESTED BY HEALTH UNIT TOOK SAMPLES, MOE ANALYSED SAMPLES

	Communal Well Overbur. MOE 3695	King Calcium Overbur. MOE 3142	C.Evans Overbur. MOE3106	Parcham Overbur. MOE1846	Crawford Shale BR. MOE1835	Mohawk Raceway Dolomite MOE1857	Burt D. Dolomite MOE4211				
Fecal Coliform MF	< 2	< 2	< 2	< 2	< 2	< 2	< 2				
Total Coliform MF	< 2	< 2	< 2	< 2	< 2	< 2	< 2				
Fecal Streptococcus MF	< 2	< 2	< 2	< 2	< 2	< 2	< 2				

NOTE. concentrations in p.p.m. unless otherwise noted.

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PROJECT 81-126

TABLE 3 SHEET 3

WATER ANALYSIS RESULTS (MOE ANALYSES)

SAMPLING LOCATION CAMPBELLVILLE, KELSO, KELSO RESERVOIR TESTING LAB. REGULAR MONITORING PROGRAM - REGION

PROPERTY	JANUARY 15, 1982 Campbellville well	Kelso Well (Milton)	Kelso Reservoir									
CONDUCTIVITY µMHOS/CM	850	590	600									
pH	7.8	7.8	7.9									
HARDNESS ($CaCO_3$)	280	254	246									
ALKALINITY ($CaCO_3$)	302	240	240									
CHLORIDES (Cl)	80	36	36	NOTE: Campbellville well generally 100± ppm. High in November 1981, 110 ppm								
SULPHATES (SO_4)	28	27	29									
MANGANESE	0.002	0.002	<0.002									
NITROGEN (N) Total Kjeldahl	0.4	0.4	0.4									
NITROGEN (N) Free Ammonia												
NITROGEN (N) Nitrite												
NITROGEN (N) Nitrate	1.7	0.2	0.4									
Potassium (K)	1.7	1.4	1.5									
Magnesium (Mg)												
Calcium (Ca)												
Sodium (Na)	56	16.5	17									
Iron (Fe)	0.01	<0.01	<0.01									
TOTAL DISSOLVED SOLIDS	490	345	350									
TOTAL ORGANIC CARBON	1.0	1.2	1.2									
FLUORIDE	<0.1	<0.1	0.1									

NOTE: concentrations in p.p.m. unless otherwise noted.

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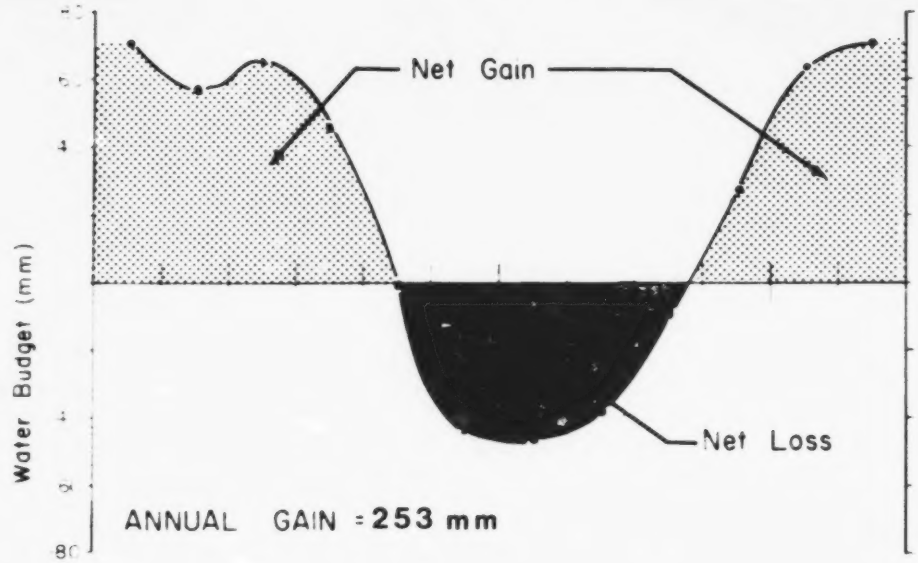
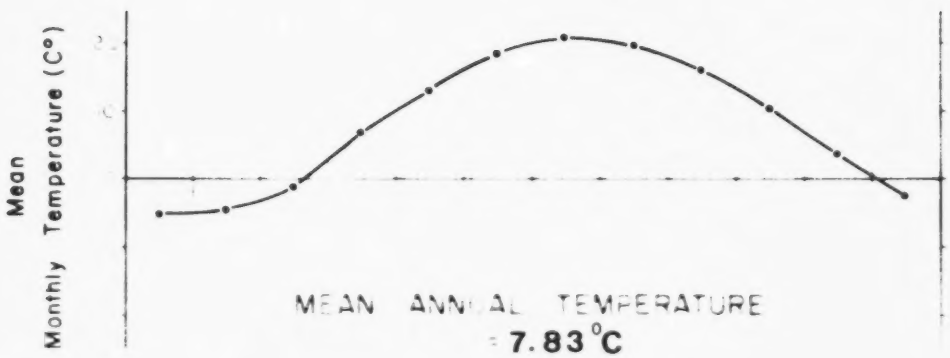
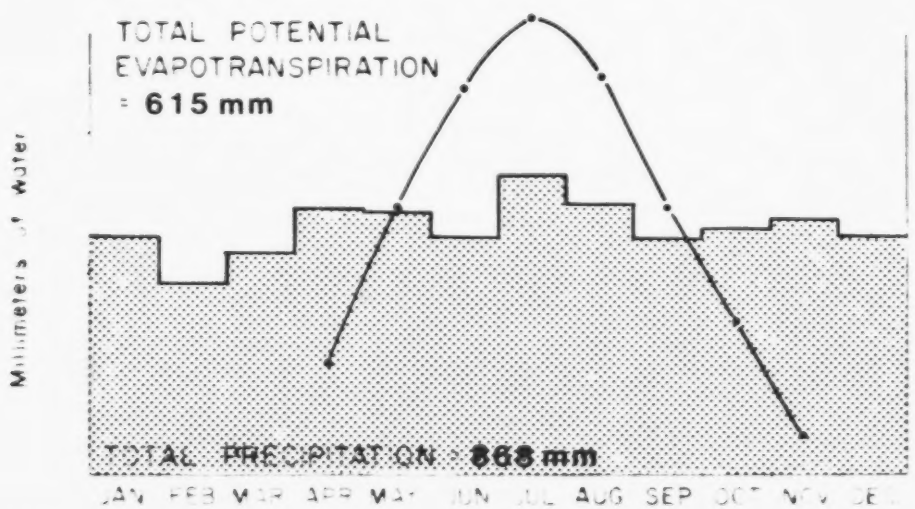
Figure 3







Water Budget and Climate Data

GALT longitude 80° 19 W, latitude 43° 20 N
Based on at least 15 years of records

Project 81-126

Gartner Lee Associates Limited

APPENDIX 2

METHODOLOGY

METHODOLOGY:

The initial phase of the study consisted of an office review of available published and unpublished geological and hydrogeological maps and reports pertaining to the area. Ministry of the Environment (MOE) water well records were searched and details of selected wells were recorded and plotted onto base maps. Aerial photographs of the area were stereoscopically interpreted to provide additional details on the surficial geology, surface drainage characteristics and cultural activities. These data were brought together to provide a three-dimensional framework of the study area.

The water well records for selected existing drilled well supplies were analysed to provide general details on the characteristics of the various ground water aquifers present in the area. Existing pumping test results and water quality data for the one communal well in Campbellville and for the Town of Milton supply from the Kelso well field were examined. A house-by-house survey was carried out within the general hamlet area by staff from the Regional Health Unit in order to obtain further information regarding the existing ground water usage. Seven water samples were collected and analysed to provide chemical data on the various aquifers.

Discussions were held with Regional staff from the Public Works, Planning and also Public Health Departments regarding the existing and proposed developments.

Commercial property owners north of Highway 401 and developers were also contacted regarding their particular enterprises.

All these data were brought together to provide as much detail as possible regarding the ground water supply, the existing ground water usage and current sewage disposal practices for the Hamlet of Campbellville. Recommendations for future ground water usage and potential impact of subsurface disposal of septic wastes on the ground water supply were then formulated. This report was then prepared to document the study findings.

APPENDIX 3

TERMS OF REFERENCE

APPENDIX A

REGIONAL MUNICIPALITY OF HALTON

PUBLIC WORKS DEPARTMENT

TERMS OF REFERENCE

HYDROGEOLOGICAL INVESTIGATION FOR THE HAMLET OF CAMPBELLVILLE

PROJECT NO. PR-637

A. INTRODUCTION

The purpose of the Study is to determine the adequacy of long term groundwater supply to support new development in the Campbellville Secondary Plan Area indicated on the enclosed plan, without detriment to existing ratepayers. As the findings of this study will provide an input into the decision making process relative to future growth, it is important that information, upon which the recommendations are based, be as accurate as is practical.

B. TERMS OF REFERENCE

1. The Study will evaluate a water supply consisting of individual private wells to serve existing residences and future development.

2. Evaluation and comment on the existing communal well will be necessary and the possibility of locating a communal supply of water to serve both existing and proposed development explored. Such evaluation shall advise on a program and probable cost to locate such a communal supply.

3. Contact Regional staff, Ministry of the Environment, and existing inhabitants, if necessary, to obtain current and past individual and communal well water quantity and quality problems. Advise how future development will impact these wells and recommend solutions to this impact.

4. Advise the recommended minimum yield required for single family residences.

5. Advise the minimum size of lots in each area of future development with respect to groundwater availability.

6. Advise what phasing, if any, is required for future growth. One aspect of this may be that growth in certain locations may be permitted, while growth in other locations may be delayed, depending upon the impact the permitted growth will have on the aquifer(s).

B. TERMS OF REFERENCE (Contnd.)

7. Recommend the necessary future test well construction and pumping, if this is required, to support the report findings.

8. Advise the well water quality that can be expected as well as quantity.

9. Evaluate the possible impact of septic tank system effluent from proposed developments on the ground-water supply.

10. Assess the possible effects on the Town of Milton water supply of increased water extraction and septic tank system effluent in the Campbellville area.

11. Study the following reports:

    (a) Rural Servicing Study, September 1979 by Underwood McLellan (1977) Ltd.

    (b) Hydrogeological Investigation for the Hamlet of Kilbride, PR-597, December 1980 by Hydrology Consultants Ltd.

12. The following meetings shall be considered to be part of this study:

    (a) Two meetings to review the draft report.

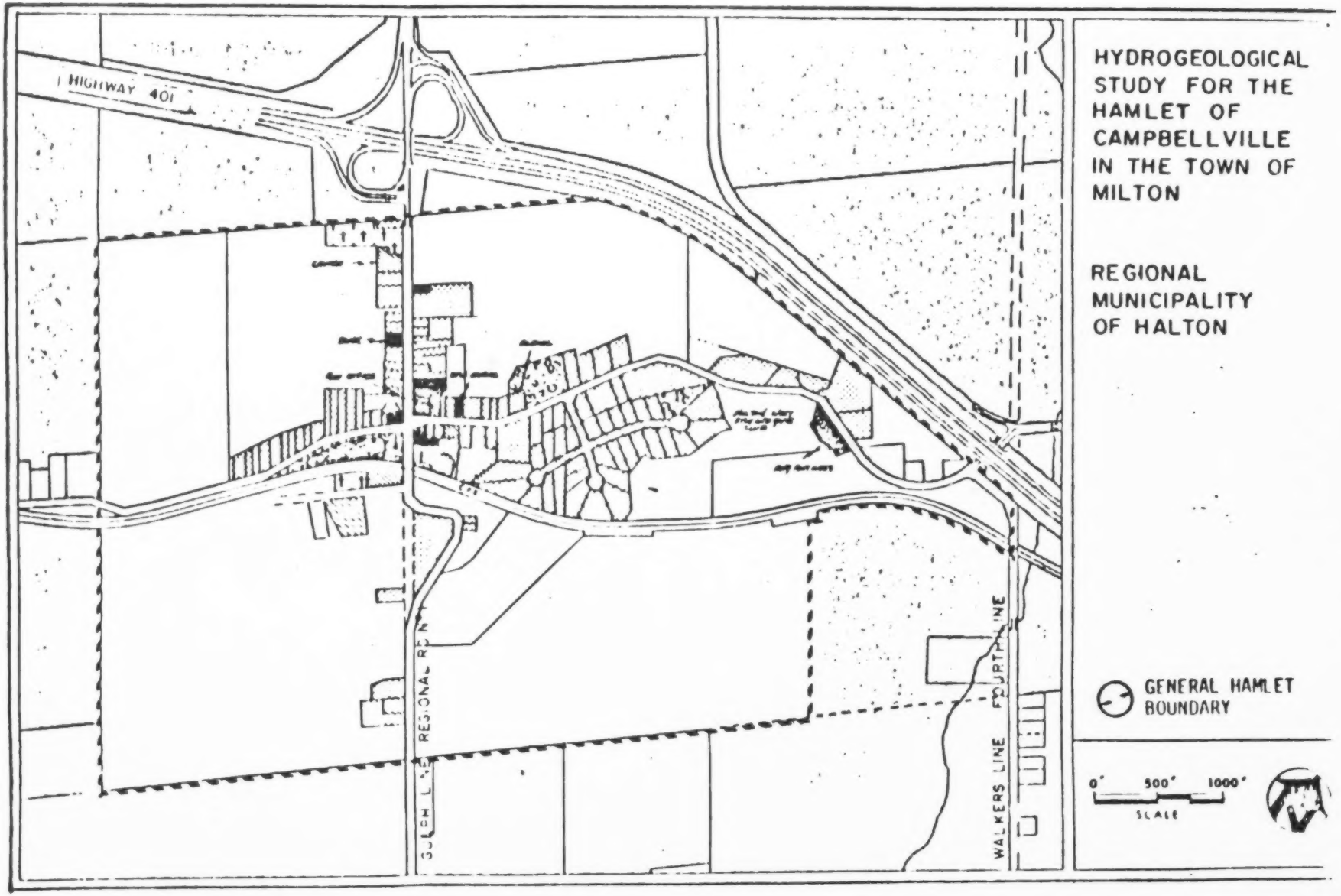
    (b) One public meeting.

13. The following are the number of copies of the reports that are considered to be part of this study:

    (a) Fifteen copies of the draft report.

    (b) Thirty copies of the final report.

14. The draft report shall be submitted to the Region for review six weeks after authorization has been given to start the study. The final report will be completed three weeks after comments to the draft report have been forwarded to the consultant.



HYDROGEOLOGICAL STUDY FOR THE HAMLET OF CAMPBELLVILLE IN THE TOWN OF MILTON

REGIONAL MUNICIPALITY OF HALTON